SPARK

REPORT

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Science
Council of
British
Columbia

THE INFORMATION TECHNOLOGY INDUSTRY IN BRITISH COLUMBIA

A Report from the Information Technology Sector Planning Committee
of the Science Council of British Columbia

January 1988

ACKNOWLEDGEMENTS

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The committee and Noreen Angus would like to particularly acknowledge the assistance and information contributed by Mr. John Wiebe, Department of Regional Industrial Expansion; Mr. Andre Gour, Strategic Planning, Ministry of Economic Development; Mr. George Dufour, Statistics, Ministry of Economic Development; Mr. Dave Nichol, Software Industry Development Association as well as members of both the information technology industry and government who generously contributed their time and comments during the preparation of the report.

EXECUTIVE SUMMARY

- The development and manufacturing of Information Technology products is a **$1 billion** industry in British Columbia with more than **750** companies employing approximately **11,500** engineers, scientists, technologists, managers and skilled support staff during 1987.

- The Information Technology industry is "home grown" and "small business" with more than 90% of the companies employing fewer than 25 people.

- The Information Technology industry is growing at rates more than twice those of other manufacturing and primary resource based industries. If current rates of growth estimated at 20% to 50% in various sectors of the industry are maintained, the Information Technology industry will become British Columbia's third largest industry prior to 1995.

- Application of Information Technology to British Columbia's primary resource industries is necessary to the maintenance of their competitive position in world markets. The province has an opportunity to develop a strong secondary industry based on Information Technology applications that can also compete internationally.

- A growing number of companies in the Information Technology industry in British Columbia are competing successfully internationally in the areas of wireless and mobile communications, software applications and in large systems integration contracts.

- British Columbia needs to build on the strengths that have been identified in the Information Technology Industry in the province in order to keep pace with the global information technology revolution. A rapid and positive response by industry, government and educational institutions is needed with respect to the following recommendations:

  1. **Apply Information Technology aggressively in the province's primary resource industries to improve the competitive edge of those industries and to develop value added products, and in turn, develop a strong and unique Information Technology product and service industry catering to the needs of primary resource industries in the global market.**

  2. **Communicate commitment to invest in and promote the growth of the Information Technology industry through explicitly stated policies that recognize the importance of the industry to the provincial economy.**

3. Acquire and develop the experienced and specialized human resources that are critical to the growth of the Information Technology industry.

4. Increase the resources of the Science Council of British Columbia to implement effective policies and to develop appropriate programs for stimulation of the Information Technology industry.

5. Develop government and industry infrastructure within the province to reduce the risks and maximize growth opportunities for the Information Technology industry at all levels of the growth continuum.

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INTRODUCTION

The Science Council of British Columbia, whose primary role is to encourage the growth of science based industries in British Columbia, is currently engaged in developing a long range plan in order to play a proactive role in the stimulation of economic development in high technology and primary resource industries within British Columbia. The planning process which started in the spring of 1987, has resulted in the Science Council and the provincial government agreeing to the following mission:

> **To identify and promote opportunities for the economic development of British Columbia by drawing on the science and technology community for creative applications of innovative science and technology.**

Each of the sub-committees or sectors under the Science Council are charged with the responsibility of developing individual strategic plans and with the drafting of specific recommendations that will lead to the stimulation of innovation and economic growth within the sector. The sector plans will be the basis for the development of consolidated Science Council recommendations and implementation plans for presentations to governments, the high technology community at large and other appropriate organizations.

For this sectoral planning process, the communications and electronics and the computers and computing sector committees have been amalgamated to develop a combined strategic plan for what is commonly known as, Information Technology.

The objective of this planning document, prepared for the Science Council, is to recommend:

> **How to Focus science and technology resources in the areas of information technology in order to stimulate and maximize economic growth within the Province of British Columbia.**

The content of the document is based on extensive input and deliberation of the members of the Information Technology Sector Subcommittee who bring considerable personal experience and knowledge of the local industry, academic institutions, and governments. It is also based on discussions with local industry representatives, review of previous private and public sector reports and other valuable survey documents and statistics. Although accurate and up-to-date information and statistics, specific to the Information Technology industry in British Columbia are seriously deficient, and the planning time period has been too short to conduct extensive primary research, the document attempts to summarize the knowledge, experience, and views of a diverse group of experts in this sector who have formulated five major recommendations for economic growth within the Information Technology sector.

1. INFORMATION TECHNOLOGY - A BRITISH COLUMBIA INDUSTRY WITH A FUTURE

o The World's New Industrial Revolution

The information technologies are among the fastest growing industries in the world today. In Canada, the software and EDP industries have consistently grown faster than the GDP since 1977, with growth rates accelerating after 1980, resulting primarily from the advent of micro-electronics. Of the 18,000 software companies estimated in North America today, most did not exist in 1980. In the United States, the domestic product of the electronics industry, estimated at $200 billion in 1986, has surpassed the traditional industrial mainstays of the American economy, automobiles, steel and chemical production.[1]

The rapid growth of the information technologies are the driving force of a technological revolution that will be comparable in economic force and impact to the industrial revolution which marked the western world's transition from an agricultural society. However, this new revolution is occurring at a much faster pace than the last one. In less than 10 years, the economic growth of North America and other western nations has slowed while new leaders have emerged. Japan, Korea, Singapore and other Pacific Rim countries are experiencing unprecedented economic growth and prosperity primarily as a result of their rapid development and exploitation of information technology based products.

The Organization for Economic Cooperation and Development (OECD) has stated that, "the electronics complex during the next quarter of a century, will be the pole around which the productivity structures of the industrial societies will be reorganized."[2] Canada's ability to compete with the industrialized nations of the world clearly depends upon the speed and efficiency with which we are able to develop and apply the information technologies and to build upon the strengths in this industry which have already been established.

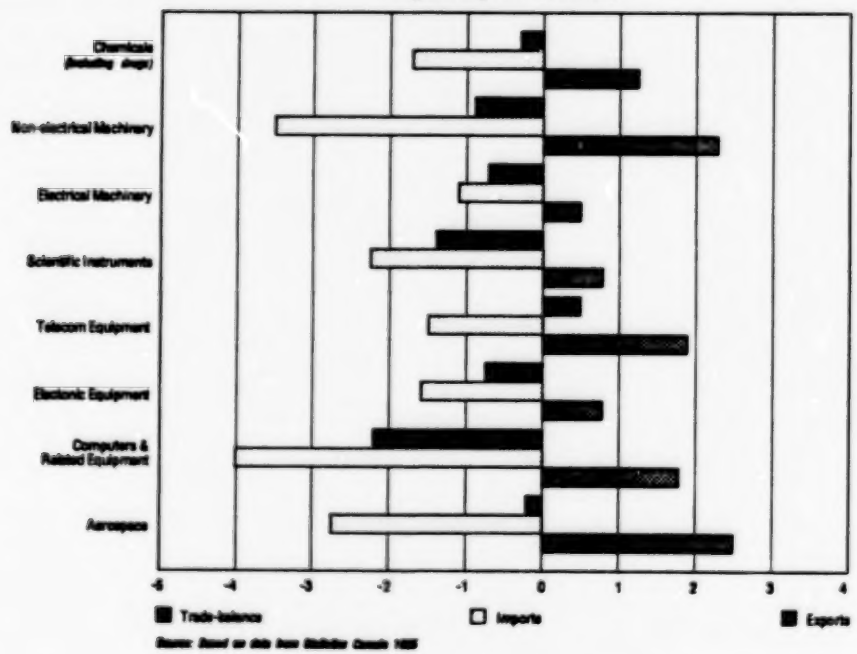
1 1987 Edition Electronic Market Data Book, Electronic Industries Assoc. Washington, D.C.

2 Software: An Emerging Industry, Wescon Communications Studies and Research Ltd. Vancouver, B.C. 1985

Canada's Position in the Revolution

To date, Canada has been generally unsuccessful in advancing to the front lines of the information technology revolution. In most areas of information technology, we have come to rely increasingly upon other nations to supply our needs. Exhibit 1 shows the balance of trade in high technology products with a deficit of $4.5 billion in 1985. Canada has shown leadership only in the communications industry where a positive balance of trade has been maintained since 1981.

Exhibit 1
1985 High Tech Sector Trade
Imports/Exports ($Billion)



The application of the new information technologies to the primary resource, manufacturing and services industries is as important to Canada's economic prosperity as the production and export sales of information technology products. The information technologies are considered to be "enabling" tools that permit rapid change and increased production and efficiency in virtually all industries.

However, a recent survey conducted by the Economic Council of Canada "Working With Technology", indicates that Canada tends to be slow in the introduction of new technologies compared to other industrialized nations, particularly Japan, the United States and Europe.[3] The Economic Council has also stated that these countries are ahead of Canada not only in automating industry, but in making better use of the computer based equipment that is being applied, through utilization of the skills of highly trained workers who are often involved in the design and implementation of new systems.

There remains a widespread fear throughout North American society that the growth of the information technologies will ultimately have a negative impact on employment opportunities. However, experience to date has demonstrated that this fear is largely unfounded. In fact, the intensive users of high technology products have maintained their employment levels, while wages and salaries have increased considerably (See Exhibit 2).

Research and Development - The Fuel For The Industry's Growth

The building of factories and machinery and the movement of the population from the countryside to the city, provided the fuel for growth in the industrial revolution. Today's information technology revolution is fueled primarily by the research and development activities carried out by a growing population of highly skilled and specialized scientists and engineers working in industry, post secondary institutions and government.

The dominance of the information technology markets by the United States and Japan has occurred in direct parallel to the investment in industrial R&D. Exhibit 3 shows Canada well behind most of the industrialized nations in industrial R&D as a percentage of the domestic product of industry. There has been relatively little change in this position since 1967.

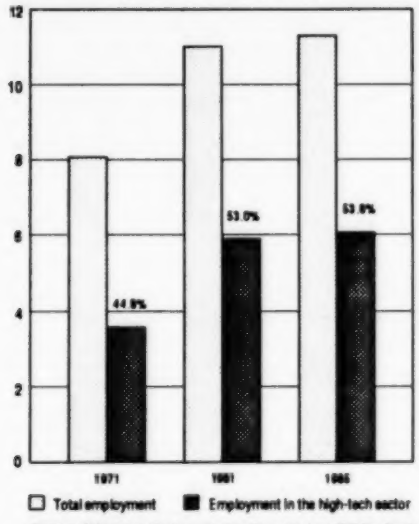
Unlike most other industries, the information technologies live or die based on the size and effectiveness of their investments in R&D. Exhibit 4 shows the R&D/sales ratios of the five leading industries in the United States. The R&D expenditures required in the aircraft and electronics industries are clearly much greater than those in other industries.

Having stated the importance of R&D to the information technologies, British Columbia's gross expenditures on R&D (G.E.R.D.) give even greater cause for alarm in gauging the ability of British Columbia's industry to compete in the global race to grow and develop. Exhibit 5 shows British Columbia's G.E.R.D./GDP ratio far behind other countries and most provinces in Canada.

3 Making Technology Work - Innovation and Jobs in Canada, Economic Council of Canada 1987

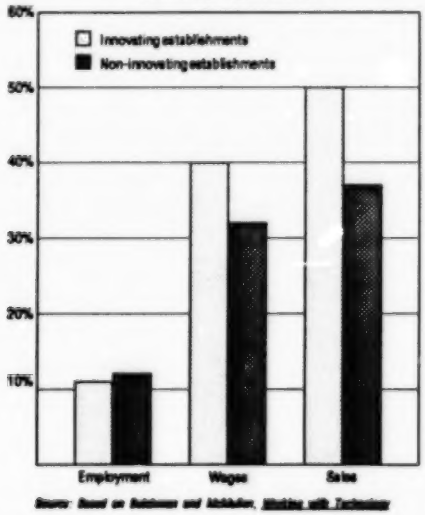
Exhibit 2

Employment Growth in Canada's High-Tech Sector
(in millions of workers) 1971, 1981, and 1985



Based on Estimates by the Economic Council on data from Statistics Canada -Making Technology Work

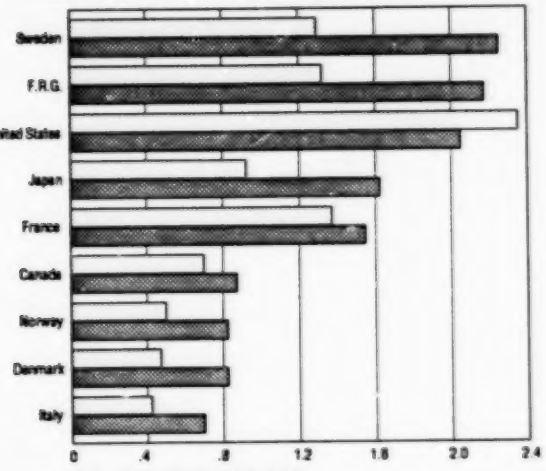
Increase in Employment, Wages, and Sales, Innovating and Non-innovating Establishments
Canada, 1980-1985



Source: Based on Baldwin and McMullen, Working with Technology

Exhibit 3

Industrial R&D as a Percent of Domestic Product of Industry, Selected OECD Countries, *1967 and 1981*



Source: Based on data from Statistics Canada

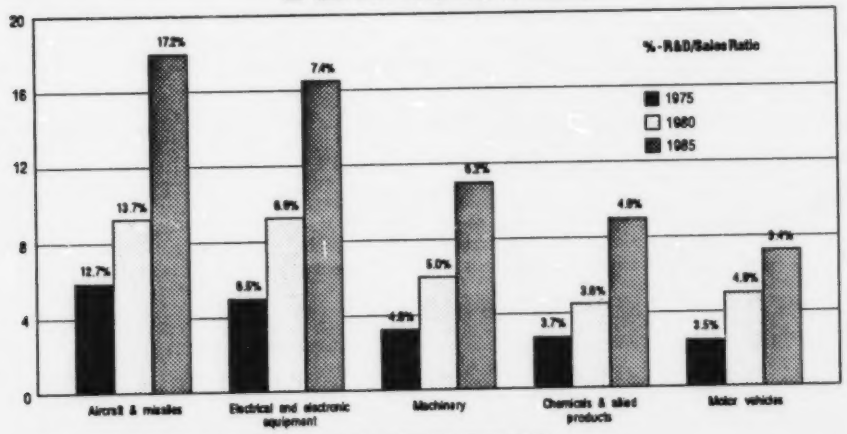
Expenditures on Industrial R&D in the OECD
1981

Country	Percent of Total OECD	$ Million P.P.P.
United States	49.4	51,810
Japan	15.7	16,445
F.R.G.	10.3	10,825
U.K.	6.7	7,115
France	6.1	6,379
Italy	2.5	2,591
Canada	1.5	1,616
Sweden	1.4	1,482
Netherlands	1.3	1,345
Switzerland	1.3	1,328

Source: Science, Technology and Economic Development: A Working Paper, Minister of State, Science and Technology 1986, based on data for the OECD

Exhibit 4

Total R&D Expenditures and R&D/Sales Ratio of Five Leading Industries in the U.S. *1975-1985 ($ Billion)*

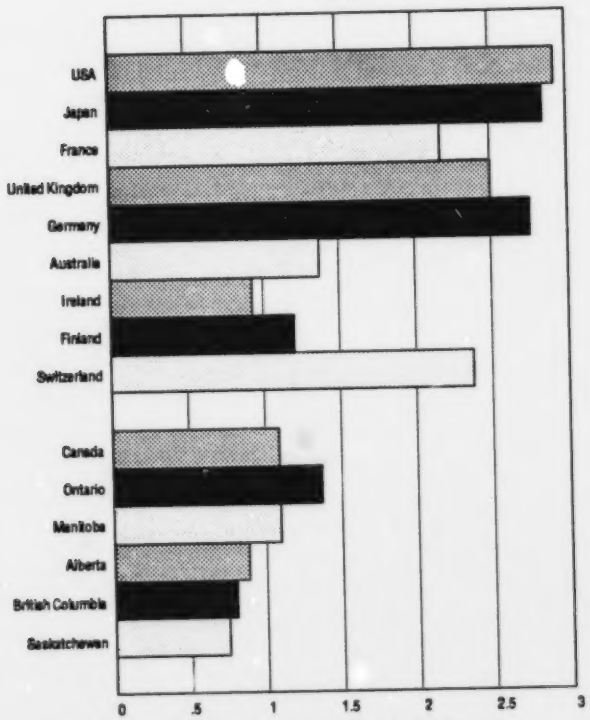


Source: 1987 Edition Electronic Market Data Book, Electronic Industries Association, Washington, D.C.

Exhibit 5

G.E.R.D. as a Percentage of G.D.P.

1983



Source: Based on data from Science, Technology and Economic Development: A Working Paper, Ministry of State Science and Technology, 1985

The Benefits of Focussing R&D Expenditures

The leaders in the information technology revolution are discovering that they cannot move on all fronts and unless they focus their R&D efforts in strategic areas, they run the risk of slipping behind in the race. Canada has realized the benefits of focussing R&D efforts in the communications industry where a high percentage of total R&D expenditures have been focussed by both industry and government during the past 15 years. The challenge during the next decade will be to continually refocus on areas that will give the industry a strategic advantage in the rapidly developing global markets for information technology products.

The Information Technology Industry in BRITISH COLUMBIA

The information technology industry in British Columbia is relatively new with most of the companies starting or experiencing their major growth after 1980. The formation of a large number of new companies, combined with rapid growth, has resulted in a lack of clarity regarding the size and shape of the industry. In order to fill this gap, the Information Technology Subcommittee of the Science Council of British Columbia prepared a list of companies engaged in the development and/or production of information technology products in British Columbia. A summary of this listing appears in Exhibit 6. Although the list requires further refinement, it does provide a picture of a major industry in British Columbia.

Sales Employment and Growth

The estimated total gross sales revenues for the information technology sector in British Columbia were estimated at slightly more than $1 billion based primarily on information available at the end of 1986. Total employment in the 794 companies listed was more than 11,500. (The methodology used in estimating these figures is discussed in the Appendices).

Employment and sales estimates are understated as the listing excludes companies such as British Columbia Telephone, British Columbia Hydro, major computer hardware suppliers and computer sales and service companies which employ significant numbers of information technology workers, many of whom play an important role in the growth of this industry.

Information regarding sales and employment growth in the industry is incomplete,but has been estimated by the Ministry of Economic Development at 26% annually. A recent report on the British Columbia software industry, "British Columbia Inc.", prepared on behalf of the Software Industry Development Association of British Columbia, estimates recent growth in sales of software companies at 50% annually.

EXHIBIT 6

INFORMATION TECHNOLOGY INDUSTRY
ESTIMATED SALES REVENUE & EMPLOYMENT

Sector	# of Companies	Est. # of Employees	(2)Est. Gross Sales Revenue (1986)
Communications			
Telecommunications	36(1)	345	
Mobile Wireless	25	1,430	
Satellite	17	3,357	
Sub-total	78	5,632	$563,200,000
Electronics			
Electro Optical	10	223	
Micro Electronics	30	374	
Transducer Sensor	27	353	
Test Diagnostic	13	55	
Process Control	39	624	
Products Misc.	91	1,094	
Sub-total	210	2,723	272,230,000
Research & Development	46	506	50,600,000
Computers			
Micro Computers	9	74	
Computer Architecture	5	164	
Applications	14	92	
Micro Mini	5	60	
Storage	7	387	
Sub-total	40	777	77,700,000
Software(3)	330	1,500	72,000,000
Uncategorized	90	450 (est.)	45,000,000
Total (Estimate)	794	11,588	1,080,730,000

(1) Excluding B.C. Tel
(2) Estimated Sales based on $100,000 per employee except in the Software Industry
(3) Software Industry revenue based on estimates in the report "A Strategic Audit of the British Columbia Software Industry" - Corum Group Ltd., October 1987.

Source: Data base prepared by Noreen Angus & Associates from the membership lists of the Electronic Manufacturer's Assoc., B.C. Microelectronic Society, Software Industry Development Association, Ministry of Economic Development High Technology Listing

The Industry's Position vs Other major Industries in British Columbia

Based on 1986 production values, the information technology industry is the sixth largest industry sector in British Columbia and the third largest secondary manufacturing sector outside of the forestry and mining related industries (see Exhibit 7). Compared with historical growth rates in British Columbia's major industries, the information technology industry is by a substantial margin, the fastest growing industry in the province. While many factors could change economic growth rates in British Columbia's major industries, if current rates of growth were to continue, the information technology industry would compete with the mining as British Columbia's second largest industry prior to 1995 (see Exhibit 8).

Exhibit 7

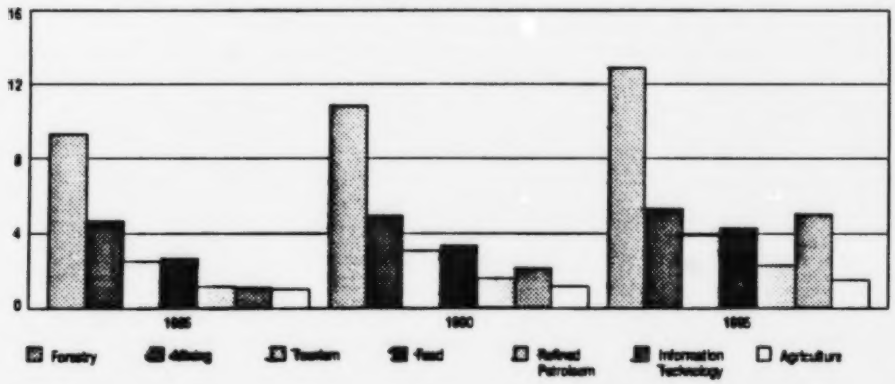
Value of Production and Estimated Growth of Major Industries in British Columbia *($ Millions)*

	Production (1986)	Average % Growth (1984-1986)
Forestry	9,329.0	3.9
Mining	4,699.0	1.4
*Tourism	2,500.0	5.7
Secondary Manufacturing (excluding forestry and mining-based products) Total:	8,709.0	
Four Largest Sub-Sectors		
Food	2,740.0	5.5
Refined Petroleum	1,179.0	8.9
Information Technology	1,080.0	26.0
Transportation Equipment	785.0	3.6
Agriculture	1,003.0	4.7

*1987 figure substituted for 1986
Source: Ministry of Finance, Financial and Economic Review (1987-1987)

Exhibit 8

Projected Value of Production in Major Industries in British Columbia
1986-1995 ($ Million)



While some may perceive that the information technology industry in British Columbia is enjoying rapid rates of growth, in comparison to growth in the industry internationally, British Columbia is struggling to keep pace. The challenge now facing the information technology industry in British Columbia is to develop a strategy that will focus the attention and economic resources of government, industry and the

education system on the opportunities which offer the best chances of surviving and ultimately profiting from the information technology revolution.

2. THE INFORMATION TECHNOLOGY INDUSTRY IN BRITISH COLUMBIA - A BRIEF SITUATION ANALYSIS

Most analyses of the Information Technology industry define the area as two industries:

- the electronics industry which contains those companies which develop and/or manufacture electronics, communications equipment and computer hardware; and
- the software industry which contains companies developing, distributing and servicing software products.

The area between the two industries is often blurred due to the increasing number of "electronics" companies that are engaging in software development to enhance their products. For the purposes of this situation analysis, the electronics industry includes communications, electronics and computers. The software industry includes only those companies developing and marketing software from British Columbia and does not include those companies with a major emphasis on distribution or service.

o The Electronics Industry in British Columbia

There are approximately 375 - 400 electronics firms in British Columbia according to the data base prepared on behalf of the British Columbia Science Council's Information Technology sub committee and a recent analysis prepared by Touche Ross from the Statistics Canada Standard Industrial Classification codes.[4] The size of these companies, relative to those in the other western provinces, was estimated by Touche Ross as follows:

# of Employees	# of Companies			
	British Columbia	Alberta	Saskatchewan	Manitoba
100+ Employees	10	9	3	6
25 - 99	24	18	6	12
Less than 25	360	270	90	180+
Total	394	297	99	198

- On average, companies in Quebec and Ontario are 30% and 80% larger, respectively than those in British Columbia.
- Of those companies in Western Canada with more than 100 employees, approximately 50% are branch plants and 50% are indigenous.

4 "Sector Paper of the Electronics Industry in Western Canada" prepared for the Department of Regional Industrial Expansion by Touche Ross Management Consultants, April 1987.

- Indigenous companies in British Columbia have one of three origins: Universities - primarily U.B.C.
  Industry Spin Offs
  Entrepreneurs

  While the majority of companies were started by entrepreneurs, many of the larger companies grew out of U.B.C. or were industry spin offs.

- A significant number of branch plants are Canadian owned. The majority of the indigenous companies are privately or publicly held by Canadians.

- The industry is dominated in sales and employment by the telecommunications industry with many of the smaller companies manufacturing products for this industry.

- The larger companies export the majority of their product.

- A few companies in the industry in British Columbia are beginning to manufacture products for the resource industries, particularly oceanographics and forest products.

- **The Software Industry in British Columbia**

The number of firms engaged exclusively in software in British Columbia is very difficult to estimate with any accuracy due to the nature of the industry. It is a relatively easy industry to enter, requiring little in the way of equipment, space, etc. Many companies are started by individuals working part time on software development while employed in another area, often totally unrelated to the industry.

The Information Technology Sub Committee's data base identified 330 companies in British Columbia employing a minimum of 1,500 people. However, the recent report on the software industry sponsored by the Software Industry Development Association, identified a total of 250 firms.[5] This comprehensive analysis of the industry, prepared by the Corum Group in Seattle, revealed the following information:

- Total sales were estimated at more than $73 million in 1987.

- The annual growth rate in the sales of software companies in British Columbia is estimated at 50%.

- 40% of the companies surveyed had been started since 1984 and 95% since 1978.

5 "B.C. Inc." The Software Industry in B.C. prepared for the Software Industry Development Association by the Corum Group - Seattle, Washington 1987

- 53% of the companies have fewer than 6 employees while 10% have 26 or more employees. Comparisons with a previous analysis indicated that companies are growing quickly in size.

- 97% of the companies are headquartered in British Columbia with 80% in Vancouver and 20% on Vancouver Island.

- Only 11% of the companies were financed with venture capital. Personal funds and bank loans were the most common sources of capital.

- Most companies market two or fewer products with packaged products for vertical software applications being the most common.

- Products are sold in a wide variety of markets with the most common being general business and education.

- Most British Columbia software products are designed exclusively for microcomputers.

- In 1987, 63% of the companies expected to make a profit, 21% to break even and only 16% expected to lose money.

- Approximately 50% of the companies consider the United States to be an important market. Very few firms have significant sales in Europe or the Pacific Rim.

- Financing is viewed as the greatest barrier to growth and expansion into export markets.

3. THE CURRENT FOCUS OF THE INFORMATION TECHNOLOGY INDUSTRY IN BRITISH COLUMBIA

The development of technology now transcends national boundaries and in the future, no one country will be capable of originating more than a small fraction of the science and technology required to sustain the accelerating pace of world needs. This is particularly true in the information technology industry where all the industrialized nations are beginning to discover that they must increasingly specialize and develop products for niche markets. In order to remain competitive in the rapid race to develop and apply information technology, countries will be forced to become more keenly aware of their individual areas of technological strength and to use these areas to gain and sustain an edge.

This section of the report identifies three specific areas in which the British Columbia Information Technology industry has developed a focus and achieved a level of excellence that is capable of providing a solid foundation on which to develop additional strength. In addition, two major opportunities are identified which appear to be available to the industry in building additional international leadership and recognition.

- **Communications**

Canada's major area of strength in the Information Technology industry is in communications. The world leadership that Canada has demonstrated in this industry resulted in the achievement of a positive balance of trade of $441 million in 1985. Communications is also the area of high technology in which Canada is least dependent on the United States for a market for its products.

In 1985, the communications industry in Canada generated gross sales revenues of approximately $4.1 billion and employed approximately 50,000 people.[6] Since 1974, the Canadian communications industry has shown an average annual growth in sales of approximately 23% annually, of which 73% is exported.

British Columbia's Focus on Wireless and Mobile Communications

British Columbia has followed the growth path of the Canadian communications industry. Communications is the major focus of the British Columbia information technology industry, generating an estimated $500 million in annual sales and employing approximately 5,000 people.[7] The British Columbia communications industry has distinguished itself in Canada by developing a critical mass around the area of wireless and mobile communications. More companies are developing and selling products related to microwave, mobile and satellite communications than in any other area of Canada. Annual sales of wireless and mobile communications products were estimated by industry experts at $177 million in British Columbia during 1987.

An Initiative Proposed for the Wireless and Mobile Communications Industry

A proposal to establish a Wireless Communications Research Centre of the Department of Communications was recently prepared by companies in this industry in British Columbia and is currently under consideration at both the provincial and federal levels. The proposal is based upon the industry's perceived need to establish the major government R&D activities in these technologies in close proximity to the critical mass of industry. The industry feels strongly that technology transfer occurs primarily through frequent contact between scientists and engineers and that R&D activities are more effectively focussed when driven by industry.

6 Electronics Industry Performance Statistical Summary - Regional Industrial Expansion 1985

7 Based on estimates prepared from the Information Technology Committee Sector Committee of the B.C. Science Council 1987

The proposal presents a very bright future for the mobile/wireless communications industry world wide. Exhibit 9 summarizes world market projections for wireless communications products. The size of the North American markets accessible to industries in British Columbia will increase by an estimated 54% between 1984 and 1995.

Assuming that British Columbia companies can continue to effectively exploit these expanding markets, the province stands an excellent chance of becoming a world leader in wireless communications.

EXHIBIT 9

SUMMARY OF WORLD MARKET PROJECTIONS FOR WIRELESS COMMUNICATIONS ($000,000)

	NORTH AMERICAN MARKET			AVERAGE ANNUAL ACCESSIBLE OFF-SHORE MARKET
	1985	1990	1995	1995
PERSONAL COMMUNICATIONS				
Mobile Telephone switching equipment base stations radio telephones	750	630	582	600
Paging	120	160	252	80
Cordless traditional new development	660 --	520 200	425 400	400 400
SATELLITE				
Space Earth	650 402	650 600	650 800	650 800
TWO-WAY RADIO	1,100	2,300	3,000	1,400
Public safety Dispatch Industrial serv Land transport Marine transport Aviation Amateur General radio service				
MICROWAVE	425	450	250	500
HF RADIO Non-military	12	15	15	35
	4,131	5,525	6,374	4,865

Source: Proposal to Establish the Wireless Communications Research Centre of the Department of Communications 1987

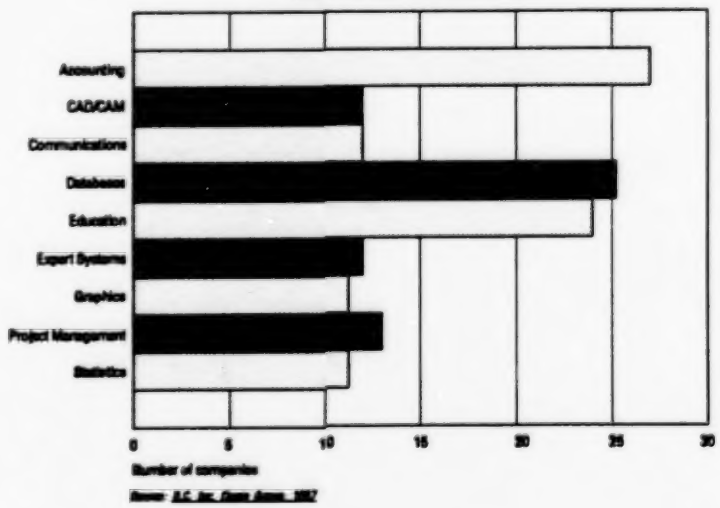
o **Applications Software**

As demonstrated in the situation analysis of the software industry in British Columbia, growth in sales is occurring very rapidly. While the industry is still comparatively small, it has the advantage of being focussed on applications software, the fastest growing sector in the software industry. The revenue in North America, generated from application packages, was estimated at more than $5 billion annually in 1986. North American markets for software applications are projected to grow at 34% annually into the 1990's, compared to a projected 31% and 21% in systems software and systems development.[8]

The "British Columbia Inc." report showed that more than 50% of the total software revenue generated in British Columbia, or approximately $36.5 million is derived from the sale of application packages. Exhibit 10 illustrates the various types of software applications that the companies are involved in.

Exhibit 10

Focus of Applications Software Companies in British Columbia *1987*



8 Software: An Emerging Industry, Nescom Communications Studies and Research Ltd. 1985

- **Systems Integrators**

A growing number of companies in British Columbia in the information technology industry have been successfully competing as system integrators both nationally and internationally. Companies such as Nexus, Glenayre, Epic Data, Canac-Microtel, Mobile Data Incorporated, MacDonald Dettwiler, Telecommunications Systems International (B.C. Tel subsidiary) and many others have been providing turnkey or custom systems, incorporating both in-house software and hardware products and products from other national and international vendors. Companies with expertise to undertake major systems projects involving networking, communications, data acquisition, data processing, database management, as well as having the ability to deliver, planning, design, development and engineering and installation service, are highly sought after both within and outside of Canada. Many of the systems integrators in B.C. with specialized products and technical knowledge have demonstrated their unique ability in this area by successfully competing in both national and international arenas.

As the Canadian and U.S. governments and many of the developing countries prepare to let large information technology oriented (telecommunications, data acquisitions and processing, system integration, supervisory and control, etc.) turnkey systems contracts, both military and non-military types, a major area of business opportunity for British Columbia information technology companies with unique products and services capabilities will open up.

- **Application of Information Technology to The Primary Resource Industries**

The information technology industry in British Columbia currently faces an exceptional opportunity to develop another focus - the application of information technology to the primary resource industries. Canada's world leadership in the supply of forest products continues to dominate the image of our country's economy held by most countries. In British Columbia, the forest products industry will continue to provide the basis for our economy for many years to come. In order to maintain their dominance in world markets, the Canadian forest products industry is becoming increasingly aggressive in the application of the information technologies, although the levels of capital spending remain much lower compared to those in Scandinavia and the United States.

A recent report to the British Columbia Science Council by consultant, Dr. John Madden, reveals a major opportunity for both the forest industry and the information technology industry that has not been fully exploited. According to Dr. Madden's analysis, the Canadian forest products industry is showing an increasing tendency to import the technology developed by the United States, Sweden and Finland, who have used their forest products industry as a basis for the creation

of a strong secondary industry. Concern is expressed in the report that Canada, and British Columbia in particular, is not taking full advantage of the presence of a large primary resource industry to develop a secondary industry.

Dr. Madden's report identifies immediate opportunities in monitoring and control instrumentation, control systems, software, communications and robotics. He also concluded that significant developments in any of those areas could have a substantial positive impact on the productivity of the forest products industry.

British Columbia is one of the few places in the world to have most of the primary resource industries in one place. The strength and relative prosperity that has been developed in these industries could provide the required base to build a world class centre for the application of information technologies. The first steps toward achieving such a reputation are to identify more specific opportunities similar to those outlined in the Madden report, in which to focus R&D efforts and to develop and attract the talent and expertise required to build this secondary industry at a pace that will overtake similar efforts elsewhere.

A New Initiative in the Application of Information Technology to the Primary Resource Industries

MacDonald Dettwiler (MDA) is currently developing a proposal to define a national Centre of Excellence in Resource Information and Management Systems. The Centre would focus on the development of new products, technologies and processes for cost-effective management and exploitation of provincial resources.

Objectives include action to:

- encourage basic scientific research to define resource related problems, understand processes and identify practical directions for solutions;

- promote inter-disciplinary co-operation in the development of solutions;

- create a network of common interest alliances contributing to the use of such science and technology based solutions on economic sectors that include forestry, mining, aquaculture, fishing and energy resources;

- undertake specific research and demonstration projects at sites and/or organizations throughout British Columbia;

- encourage technology transfer within and between all participating organizations and institutions; and

- establish training and development facilities for the transfer of resulting marketable technology and system operational skills.

- **Opportunities in Government**

Governments at both the federal and provincial levels have been growth industries in Canada over the past decade consuming an every increasing portion of GDP. They are often the largest market for a wide variety of products. Government procurement policies can be used as a powerful tool in the development of new industries. The local information technology industry can serve the expanding requirements of government for information technology, while creating new and unique products that can be sold in global markets.

The Federal Unsolicited Proposal Program

In Canada, the federal government has initiated an unsolicited proposal program whereby companies are given the opportunity to engage in research and development of new products that will solve problems in government or improve efficiency. These products must also show potential for commercialization and application in industry. Some companies in the information technology industry in British Columbia and other parts of Canada, have found this program to be particularly effective as a method of financing the R&D that is so critical to their survival. These same companies have also benefited from the opportunity to demonstrate their product's capabilities under real life, market specific conditions, enhancing a new product's credibility with other potential buyers.

A similar program or policies with respect to procurement, developed by the provincial government, could also be effective and benefit both the information technology industry and government. While such a policy could be applied in all areas of government, initial efforts could be focussed on two of government's major areas of expenditure.

- **Applications in Health Care and Education**

British Columbia and other governments worldwide, are becoming increasingly alarmed about the costs of providing adequate levels of service in both health care and education. At the same time, provincially based medical and education programs represent some of the largest product buyers in the world. The information technologies can be applied to these two major areas of government to solve problems and to develop products that will be attractive to other parts of the world encountering similar problems. A few information technology companies in British Columbia have already successfully developed products using the provincial government as a first purchaser. A well defined policy communicated to the information technology industry would likely expose many more opportunities of mutual benefit.

Government buying power can also have a positive impact on companies that provide service and support to information technology products. Large government contracts to information technology service companies give the companies the opportunity to build the infrastructure needed to sell their information technology services in other markets.

4. KEY FACTORS ENHANCING BRITISH COLUMBIA'S ABILITY TO COMPETE IN INFORMATION TECHNOLOGY

In attempting to target investments in research and development, education and human resources, and in government programs and policies that impact on the information technology industry, it is useful to become aware of the positive factors which position British Columbia to compete in key niche markets. This section of the report identifies five major factors that are considered by industry representatives to offer a strategic advantage to the information technology industry in British Columbia, compared to other parts of Canada and other countries.

- **Access to Key Markets in the United States and the Pacific Rim**

  The British Columbia information technology industry is beginning to experience some advantage from the close geographical proximity to a number of economic growth areas that are key markets for information technology products. Exhibit 11 shows that the Pacific Rim countries have out paced Canada's traditional export markets in growth of population, GDP and imports. These countries are becoming major buyers of wireless communication products, integrated systems and specific niche electronic products. British Columbia's growing population of Pacific Rim origin potentially offers the Information Technology industry a strategic advantage in establishing trading relationships with these countries.

  British Columbia is also within easy striking distance of the key market areas in the United States. Exhibit 12 shows that the Western United States are experiencing the fastest rates of economic growth and are likely to continue to do so.

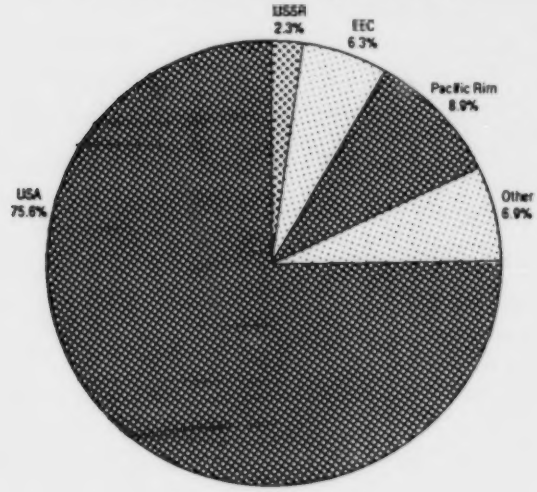
  The recent S.I.D.A. report on the software industry, referred to earlier, states that Seattle has one of the largest concentrations of software companies in the world. British Columbia's proximity to this rich knowledge base will likely generate valuable opportunities over the next decade in terms of exchange of knowledge and expertise and in the development of marketing strategies.

- **Three Major Universities and 18 Colleges with Science and Technology Programs**

  The universities play a significant role in the research and development that is so critical to the growth of the Information Technology industry. The three universities in British Columbia have developed specific R&D expertise and specialized courses in

Exhibit 11

Canada's Traditional Export Market



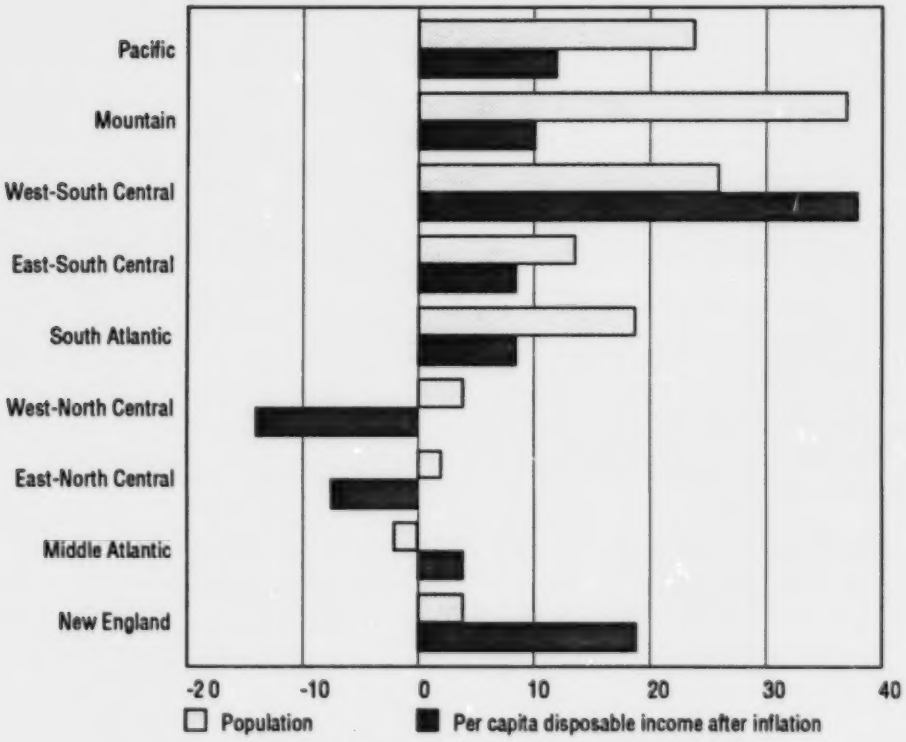
Dynamic Non-traditional Markets

	U.S.A.	E.E.C.	Middle East	Latin America	Communist	Pacific Rim
10 year change (1973-83) in imports	+261%	+145%	+637%	+40%	+183%	+310%
Share of world imports (83)	14.5%	28.8%	6.7%	2.7%	9.0%	18.3%
Canada's share of region's imports:	20%	1.0%	0.8%	2.6%	1.4%	2.1%
Population (1983) millions	234	272	146	329	383	1,470
10 year change (1973-83)	+10.4%	+2.5%	+31.1%	+29.0%	+9.7%	+14.5%
GDP (1983-C$bn)	4,013	2,840	503	732		2,431
GDP in real terms 10 year change (1973-83)	+22.4%	+18.6%	+79.5%	+41.3%		+55.2%
GDP per capita (1983) Cdn.$	17,150	10,441	3,593	2,290		1,847
GDP per capita 10 year change (1973-83)	+10.8%	+15.7%	36.9%	+9.5%		35.5%

Source: Tomorrow's Customer: Fifth Edition, Woods Gordon-Chedwyn Group

Exhibit 12

Growth in US Regional Population and Per Capita Real Disposable Income *1973-1983 (% Change)*



Source: Tomorrow's Customer 19th Edition, Woods Gordon-Clarkson Gordon

communications and software and have played a catalytic role in the start up and growth of some of the major companies in the British Columbia industry.

The universities have provided a base for the development of the Advanced Systems Institute, an organization with a mandate to attract world class scientists and engineers to carry out R&D in the advanced systems that are key to the growth of the industry in British Columbia which include the fields of computing science, microelectronics artificial intelligence and robotics.

The universities and colleges also play a vital role in educating and training the scientists, engineers, technicians and business graduates that drive the growth of the industry. There is a very strong relationship between the number of scientists and engineers as a percentage of the work force and the size and growth of a country's Information Technology industry. While there is room for improvement in the ratio in British Columbia, the Information Technology industry in this province could not survive without the estimated 3,500 college and university students graduating annually in computer science, electronics and electrical engineering. Graduates of these programs in British Columbia have been generally well received by industry.

- **Provincial and Federal Government Support**

In Canada, the federal government has supported the Information Technology industry through a variety of programs and is continuously developing new initiatives. Major new initiatives include the recently announced Western Diversification Fund and the additional $1.3 billion in financing for R&D.

Programs that have been ongoing for some time, include grants provided to industry through the National Research Council and to the universities through NSERC. Financial support to the British Columbia information technology industry from these two sources totalled approximately $6.2 million in 1987.

The Federal Department of Regional Industrial Expansion has increased funding to the "Informatics" sector in British Columbia from less than $300,000 in 1982 to more than $8 million in 1987.

The recently funded Advanced Systems Institute, jointly funded by the federal and provincial governments, is another initiative of major significance to the Information Technology sector.

The federal government has also provided significant assistance to the industry by directing large contracts to new companies in British Columbia and through providing opportunities for research and new product development through the Unsolicited Proposal Program.

Although the funding provided by the provincial government to the Information Technology industry in British Columbia is less than some other provincial governments provide to this sector, their support is important in two major areas:

a) The Science Council of British Columbia distributed a total of $2.7 million in R&D funds in 1987, of which $719,005 or 25% was spent on computers and electronics.

b) The Discovery Foundation, supported by the provincial government, manages Discovery Parks which accommodated 19 companies in the information technology industry out of a total of 48. Discovery Enterprises Inc. have provided seed venture capital to 36 companies of which 17 are involved in information technology.

Both federal and provincial governments are beginning to realize that investments in high technology show good rates of return. In a report to the British Columbia Science Council in April 1986, Dr. Craig Walden concluded that for every dollar invested by the Science Council in a total of 120 projects that had reached a firm commercial conclusion, $20.00 will be returned to the provincial economy over the next 15 years.[9] The Science Council of British Columbia is an important catalytic agent in developing a successful Information Technology industry in the province. The Walden analysis showed the greatest short term returns in aquatics, computers and electronics.

The Discovery Foundation has in the last seven years, assisted 171 companies which have generated $245 million in sales and created 1,900 jobs. The provincial capital grant of $6.2 million, plus the 1987 portion of $6.1 million of a 5 year $50 million repayable loan, has generated $37 million in private and federal investment in 36 companies.

- **Strong Primary Resource Based Industries**

As discussed earlier, British Columbia is one of the more fortunate areas of the world in terms of the primary resources that are available for exploitation. The information technology industry has an opportunity to work with the primary resource industries to develop a position of world leadership in the application of technology to these industries.

9 Twenty-to-One Payback by B.C. Science, Summary of Dr. Craig Walden's report on the Assistance Grants for Applied Research (A.G.A.R.) Program - Science Council of B.C. 1986

- **British Columbia's Environment**

  British Columbia's climate and lifestyle are a positive factor in attracting the human resources required by the information technology industry. While experienced people in the industry can not be attracted by this factor alone and must be shown other advantages to relocating in British Columbia, lifestyle is becoming an increasingly important factor in career choices, a trend that the industry in British Columbia can use to its advantage.

5. BARRIERS TO GROWTH

The information technology industry has grown considerably in terms of the number of companies entering the industry since 1980. The industry now faces the challenge of moving these companies to their next level of growth. Of the 794 companies identified in the industry, less than 20 have achieved a size of more than 100 employees. The few companies that have broken the 100 employee barrier are now faced with what is considered to be the next major hurdle in their growth - 1,000 plus employees.

There are a wide variety and complexity of factors that affect the growth of the small and medium size companies in the industry in British Columbia. The following section attempts to define the barriers to growth that are considered by industry to be common to all companies in the industry, regardless of size.

- **An Image Problem**

  In spite of British Columbia's major successes in specific niches in communications, electronics and computers, there is an overwhelming perception within high technology communities and the business communities generally, in Canada and the United States, that British Columbia is exclusively and entirely pre-occupied with the resource industry. While the resource industries are the major contributors to the provincial GDP in British Columbia and therefore deserve adequate attention, the provincial infrastructure and government policies do not adequately address the needs of the Information Technology industry. There is a lack of recognition by both government and the public at large, of the size and potential opportunities for growth in the Information Technology sector in British Columbia.

  The British Columbia industry's current lack of profile, combined with British Columbia's image as a "pulp and paper" economy, are a barrier to innovation in the primary resource industries as well as a hindrance to the attraction of new investment and the world class talents that are required for growth.

- **Lack of Critical Mass**

  The growth of the information technology industry in British Columbia is also constrained by the failure to reach a critical mass that is of sufficient size to support the interrelated network of technologies

and companies that are required. This lack of critical mass also contributes to the perception in other high technology communities in Canada and internationally that British Columbia does not provide an exciting and challenging environment in which to work. Experienced managers and highly specialized scientists and engineers, considering relocation to British Columbia, are also concerned that they will be unable to find other opportunities if the position they are offered does not work out.

The British Columbia information technology industry needs the expertise of world class engineers and managers that have experience in building medium and large sized information technology companies. At the present time, the experienced industry people in British Columbia are stretched too thin in terms of devoting more time to leading the expansion of the industry as a whole.

- **Lack of Expertise and Emphasis on Marketing**

Many of the information technology companies in British Columbia, particularly those with less than 100 employees, experience some degree of difficulty with marketing their products. Most companies in the industry are started by engineers or scientists who lack adequate background in business. Many of those individuals have difficulty in developing and implementing marketing plans for their products, particularly in the early stages of their company's growth when attention is necessarily focussed on product development. Many companies are constrained from hiring the marketing expertise required due to under capitalization. "British Columbia Inc.", the S.I.D.A. report on the British Columbia software industry, identified sales and marketing as the area in which most software companies encounter the greatest difficulty, primarily because of problems in raising sufficient funds to finance marketing activities.

Companies looking for marketing expertise are further hampered by the fact that the combination of talents - marketing and a detailed knowledge of information technology products, remains a relatively rare combination in British Columbia.

- **Inadequate Access to Risk Capital**

Many leaders in the information technology industry, as well as venture capitalists, claim that sufficient capital exists to finance and develop the information technology industry in British Columbia However, most small companies in the industry claim that they are encountering great difficulty in gaining access to the risk capital required to grow and prosper. While this problem is not unique to information technology companies in British Columbia, it is a problem that presents a major barrier to growth in the industry.

The Vancouver Stock Exchange, the premier venture capital exchange in the world for start up companies, is often suggested as a solution to the risk capital problem. The VSE has been used as a vehicle by at least 88 information technology companies in British Columbia. However, most of these companies have been small start ups and many of them have found that the time and cost involved in preparing a public offering and subsequently maintaining a position in the market, places a heavy burden on the company's management.

There are a few venture capital companies in Vancouver and only one of a significant size. This lack of competition severely limits the number of local companies that have the opportunity to obtain their risk capital through venture capitalists. To put the matter in one perspective, information technology companies in the Silicon Valley can choose from 41 venture capital companies in Palo Alto alone, all of which are equal to or larger in size than Vancouver's largest venture capital company.

Access to traditional financial institutions and other investors is hampered by the general lack of knowledge and expertise regarding high technology which prevents these institutions from gaining the confidence to invest in a rapidly changing industry. Software companies have a particularly difficult time as they have very few hard assets on which to base investments.

- **Inadequate Research and Development Funding**

As stated previously, research and development is the driving force of the information technology industry. The growth of the industry throughout the world is directly related to the amount of R & D expenditures and the success of focusing those expenditures on marketable products. Exhibits 3 and 5, earlier in the report, demonstrated the extent to which Canada and British Columbia lag behind other industrialized nations in R&D expenditures generally.

The report of the National Technology Policy Roundtable, prepared in 1986, concluded that if Canada is to compete with the world leaders in technology, the G.E.R.D./G.D.P. ratio must be quickly increased from 1.3% to 2.5%. British Columbia has a long way to go to increase the G.E.R.D./G.D.P. ratio in the province from .08 to 2.5%.

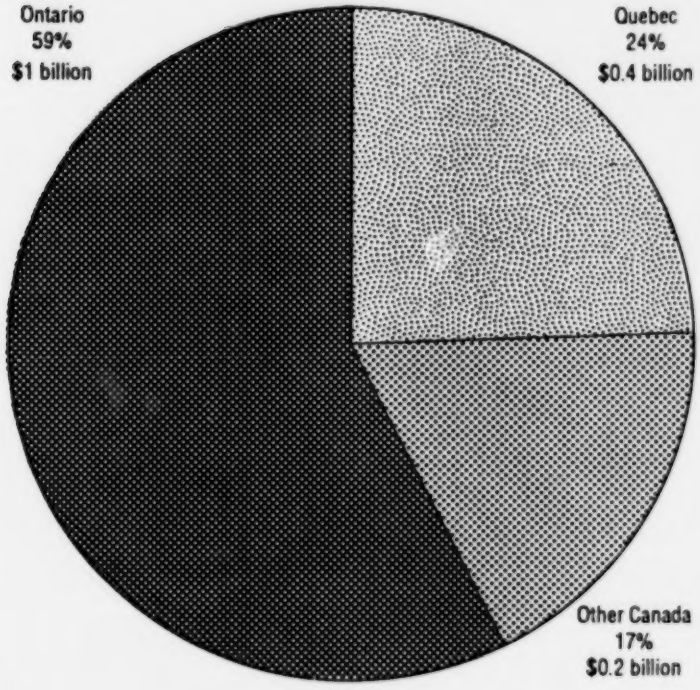
Government and University Funding

Compared to other provinces, particularly Ontario, British Columbia receives a small proportion of the R&D initiatives from both industry and government/university sources. Exhibit 13 shows the proportion of industrial R & D expenditures throughout Canada as well as sponsored research at Canadian universities. Exhibit 14 shows NSERC's largest university industry research projects in 1986. While British Columbia did not appear on the list in 1986, NSERC did provide $1.8M under this program in 1987.

Exhibit 13

Total Canadian Industrial R&D Intramural Expenditures

1985 total: $3,330 million



Sponsored Research at CanadianUniversities

1985

	Total ($,000)
Ontario	395,783
Quebec	102,045
Alberta	99,941
British Columbia	63,000

Source: Research Money 1987

EXHIBIT 14

NSERC'S LARGEST UNIVERSITY INDUSTRY RESEARCH PROJECTS*

DISCIPLINE	UNIVERSITY	COMPANIES	NATURE OF PROJECT	FUNDING ($000) NSERC	INDUSTRY
Cooperative R&D Projects					
Civil Engr.	Ecole Polytech	9 eng. firms	computer-aided design for hydro-electric projects	2,222	1,515
Chemistry	Univ. of Toronto	Allied Signal Canada Inc.	sensors based on chemo-receptive membrane tech.	780	1,050
Computer Science	Univ. of Toronto	Canstar Communi-cations Ltd.	High-speed fibre optics local area network	724	496
Industrial Research Chairs					
Electrical Engr.	Univ. of Waterloo	Bell-Northern Research	very large scale integrated circuits	930	770
Animal Biotech	Univ. of Guelph	Semex Canada	new genetic techniques for animal breeders	885	370
Meteorology	McGill	Environment Canada (AES)	atmospheric dynamics and weather modelling	550	550

*As of July 1986

Source: Research Money 1987

The provincial government in British Columbia funds R & D through the British Columbia Science Council. While the information technology industry has received approximately 25% of the Science Council's budget during the past two years, the Science Council's total recommended funds for R&D have declined from $4.9 million in 1983 to $2.7 million in 1987.

Industrial R&D

Industrial R & D expenditures are concentrated in Ontario because that is where the majority of Canadian head offices in the Information Technology industry are located. These companies in turn attract the "lion's share" of government sponsored R & D. With one major exception, the British Columbia information technology industry has experienced difficulty in persuading the large computer hardware manufacturers and some of the larger software companies to move a portion of their R&D activities to British Columbia.

The Focus of R&D

In playing "catch up" to other areas of Canada and to other countries, the British Columbia information technology industry cannot afford to invest in every new technology. R&D dollars need to be targetted toward the technologies in which market strength has been demonstrated giving us a chance to compete in global markets. R&D dollars must also be carefully divided between pure research that will keep industry on the leading edge in a few key areas and industry market driven research that will provide a rapid return on the investment.

Various analyses, including the Walden report to the Science Council of British Columbia, have concluded that the returns on investment in R&D are much greater where projects are market driven as opposed to being lead by government or the universities. Members of the industry stress that they have a much closer link with the markets and can therefore more accurately focus R&D efforts.

Most companies in the industry depend upon a short term pay back on R&D investments and are therefore aware of the need for market analysis as an integral part of the R&D process. However, none of the government funded R&D programs, including those of the British Columbia Science Council, include a market analysis component. Consequently many of the smaller companies pay less attention to this aspect of their R&D activities which often results in the loss of a market window for their products.

R&D Tax Incentives

Government taxation policies can have a dramatic impact on the investments in R&D in the information technology industry as we all learned by watching the impact of the controversial Scientific Research Tax Credit program (SRTC). In the wake of that failure, many members of the industry are concerned about the inadequacy of existing tax credit programs to support investments in R&D.

- **Education Policies**

In British Columbia, the information technology industry is well served with respect to graduates in electronics and computer science from the universities and colleges in the province. The graduates, particularly those from B.C.I.T., are acknowledged to be well trained and of immediate value to industry. While the current numbers of graduates appear to be adequate, the numbers of students graduating must increase to serve the needs of the information technology industry as it grows. The recent decline in post secondary education budgets and the many students who have been unsuccessful in gaining entrance to science and technology programs, should serve as warning signals that the needs of industry may soon exceed the supply of qualified and trained graduates. Also, the industry does currently

experience difficulty in finding graduates with specialized training in R.F., electronics, low level analog circuitry chip design and electronics which may indicate a need for changes in the curriculum at the post secondary level.

The speed of change in the information technology industry and the need for specialization requires today's science, technology and business students to become prepared for a learning process that will last their entire career. Scientists and engineers are also faced with the fact that they must become skilled in business and entrepreneurship to advance in their careers. Existing continuing education programs that attempt to fill these needs such as Simon Fraser University's Advanced Management Program are considered by industry to be lacking in accessibility due to factors such as cost to the students and lack of space. Industry representatives have expressed a need for more continuing education courses and workshops, that are specifically designed for science and technology graduates in marketing, business finance, business law, and human resources, as well as in areas of technological specialty.

Closing the Gap Between Industry and the Education System

The gap that exists between industry and the education system in British columbia remains too wide. In general terms, a lack of emphasis in the curriculum on science and technology throughout the entire education system has a negative impact on the information technology industry. Without education in the sciences, the general population fails to appreciate the impact of the information technology revolution and the necessity to invest in it.

In more specific terms, the gap between industry and the educational institutions results in missed opportunities to develop industry co-op education programs, make joint use of industrial plant and university research facilities and to discover other areas of mutual cooperation.

Recently, two major initiatives have been either suggested or implemented in British Columbia which may address some of the problems that have been identified here:

New Initiatives

In 1987, the British Columbia Institute of Technolgoy proposed that a Centre for Applied Technology be established "which would develop expertise in specific technologies and facilitate technology transfer to business and industry." A task force, appointed by the Ministry of Advanced Education and Job Training to assist in charting the future direction for the British Columbia Institute of Technology, concluded that B.C.I.T. is not the appropriate vehicle for such an ambitious project.

Instead, the Task Force suggested that consideration be given to establishing a British Columbia College or Institute of Advanced Technology that would be "elitist without apology", accepting only the top graduates of two year college diploma programs and university students of comparable stature. "This institution would not be another university, but a poly-technic facility that would stress entrepreneurship and the commercial harnessing of technology, complementing rather than competing with the existing post secondary institutions."[10]

The task force report is currently under consideration by the Ministry.

The Advanced Systems Institute which was recently initiated, has a mandate to attract world class scientists and engineers to conduct highly specialized research in the area of super computers. The ASI intends to attract 30 individuals under this program who are to be located at all three universities in the province. Both the universities and industry could benefit considerably from this initiative if close links between the ASI and industry are established early in the project.

- **Inadequate Industry Data and Infrastructure**

The information technology industry in British Columbia has reached a size that is of significant value to the British Columbia economy yet there is very little awareness of its size and value, even among members of the industry itself.

The existing level of data and information that relates specifically to the information technology industry in British Columbia, is inadequate. Basic information with respect to sales, employment, R & D expenditures and areas of product specialization are required and need to be continuously updated to assist both industry and government to efficiently prepare strategic plans. The scarce resources for R & D expenditures and government infrastructure cannot be accurately targeted without such tools.

10 Report of Task Force Concerning the British Columbia Institute of Technology October 1987, Western Management Consultants for the Minister of Advanced Education and Job Training

6. THE INFORMATION TECHNOLOGY INDUSTRY IN BRITISH COLUMBIA IN 1990 AND 1995 - WHERE DO WE WANT TO BE?

- British Columbia recognized as an exciting and stimulating environment that encourages and supports the growth of high technology industries and more particularly supports the information technology industry.

- Working toward growth targets that have been established by industry and government toward the goal of the information technology industry becoming the third largest industry in the province by 1990 and the second largest industry by 1995.

- Established as a leader in the areas of wireless and mobile communications and successful in the development of niche markets in applications software supported by expertise in new technologies that are critical to the growth of the current and future impact in technology industries.

- British Columbia recognized as a world leader in the application of information technology to the primary resource industries, leading to success in capturing significant portions of the global market for products applied to the forest products industry, mining, aquaculture, agriculture and energy.

RECOMMENDATION 1

Apply Information Technology aggressively in the province's primary resource industries to improve the competitive edge in those industries and to develop value added products, and in turn, develop a strong and unique Information Technology product and service industry catering to the needs of primary resource industries in the global market.

ACTIONS

1a) Undertake investigation of each of the major primary resource industries to identify needs and benefits of Information Technology applications and the need for increased awareness of Information Technology in the resource industries.

1b) Organize joint workshops with representatives from the Information Technology industry and each of the major primary resource industries to identify problems and opportunities to find mechanisms for joint development and implementation of solutions and increased awareness.

1c) Provide resources to the Science Council of British Columbia to establish sectoral committees to develop joint plans for effective application of Information Technology in primary resource sectors and development of unique products within the Information Technology sector.

1d) Provide incentives to post secondary institutions to offer more training including continuing education programs in applications of Information Technology, particularly in the areas of forestry, mining, agriculture, aquaculture and oceanography.

1e) Establish "first user risk reduction programs" to encourage primary resource industries to be more aggressive in applying new and innovative Information Technology developed in British Columbia.

RECOMMENDATION 2

Communicate commitment to invest in and promote the growth of the Information Technology industry through explicitly stated policies that recognize the importance of the industry to the provincial economy.

A major shift in attitude, and upgrading of status of the Information Technology industry within British Columbia is required. British Columbia, must give clear signals in the form of commitments and actions, that the information technology industry is considered vital to economic growth and therefore growth in provincial employment, productivity and income, not only in the sector itself, but also in the primary industrial sectors.

Recent initiatives in the form of the establishment of the Premier's Council on Science and Technology Policy Development, and the creation of the Advanced Systems Institute, are moves in the right direction.

Knowledge of and pride in achievements of the local information technologies are an important part of demonstrating commitment to the information technology industry. Science features, news of success, the B.C. Science Council Award, details of public and private sector activities and establishment of Science World, help towards raising the profile of this industry and high technology in general, both within and outside of British Columbia. Inclusion of the Information Technology theme in current government publicity and media programs and other advertisements will be a significant move in the right direction.

ACTIONS

2a) **Industry and government need to agree upon and establish specific targets for growth in the Information Technology industry in two, five and ten year intervals.**

2b) **The industry needs an effective organization with adequate resources to develop and implement public relations programs designed to heighten the profile of the industry. This organization should also work with industry, government, post secondary institutions, and the convention industry to draw to British Columbia, major conferences and conventions in Information Technology.**

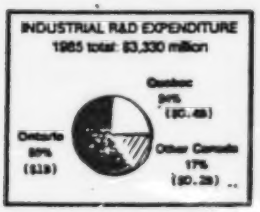
As shown in Table 15, Ontario draws by far the largest amount of Canadian industrial R & D expenditure (60% of total). However, the province of Quebec, which is a distant second, has made sweeping changes to provincial tax incentive programs with an aim to stimulating growth in the high technology industry by

drawing a significantly increased share of industrial R & D expenditure and talent. Similar changes are overdue in British columbia to set an environment for increased innovation, investment and product/service development and attraction of human resources in the Information Technology industry.

2c) Change the provincial tax structure and other financial incentive programs as other provinces including Quebec have done, to attract increased investment in Research and Development, capital and human resources.

EXHIBIT 15

TOTAL CANADIAN INDUSTRIAL INTRAMURAL EXPENDITURE



Changes in Tax Incentives

Initiative	Changes	Cost to Province
1. Industry & University R&D Tax Crtedit	From 10% to 20%	$43M
2. Tax Credit for Company sponsored R&D by full time professors	20% to 40$	
3. Income Tax Deduction for R&D flow through shares	33% limited partnerships	$46M
	66% in speculative University R&D	$ 6M
4. Two Years Provincial tax exempt for internationally reputed scientest working in Quebec		
5. Remove Provincial levies on Federal R&D tax credit		$ 7M
6. $17M fiscal 88 post-secondary funding for university/industry linkage		$17M

- **TABLE: Quebec's move to capture a larger share of industrial R&D in Canada for stimulating economic growth.**

RECOMMENDATION 3

Acquire and develop the experienced and specialized human resources that are critical to the growth of the Information Technology industry.

The government in British Columbia needs to recognize that unlike other major industries in the province, the Information Technology sector is based primarily upon talented and highly educated human resources that are very portable and "footloose". Universities and the Information Technology industry throughout North America, compete to attract the talent and expertise that are required, by developing financial incentives, offering exciting career opportunities and promoting attractive lifesytles.

As stated in Section 3, although there is an adequate quantity of well qualified graduates available from various colleges and universities, most Information Technology companies in British Columbia have difficulty in attracting experienced and well recognized specialized technical, marketing and management personnel. The Information Technology industry depends heavily on people with advanced technical product and market ideas. British Columbia will continue to face stiff competition for the critical talent pool from more well developed and desirable centres such as Toronto, Ottawa, Oregon, Silicon Valley, etc. It is, therefore, essential that as well as trying to attract talent from outside British Columbia, we should also develop the necessary talent pool within British Columbia.

As stated in Section 4, one of the major difficulties in attracting talented and experienced personnel to British Columbia is the apparent concern of having to relocate to eastern Canada or the United States at significant costs, if the company or the job does not work out. To minimize the risk, one approach may be to establish an insurance program with contributions from industry and government, which will guarantee relocation costs if an equivalent job for an individual cannot be identified within a reasonable period of time.

ACTIONS

3a) Develop a range of incentives, including income tax relief and industry/government sponsored bonuses and insurance programs to attract well recognized marketing, managerial and technical talent and to mitigate the perceived risks of relocation to British Columbia.

It is essential that academic institutions continue to emphasize general education and skills for students and maintain a certain amount of autonomy in developing their curriculum. However, mechanisms must be found for industry,

academic institutions and government to jointly focus additional resources in specific areas which are critical to the local and national industry and to the economy. Creation of Funds for Excellence is one good example of how the above initiatives can be achieved.

3b) Recognizing that CO-OP programs cost more to operate than traditional programs, but do contribute to acceleration in the development of specific skill sets required by the Information Technology industry, co-op programs should be promoted and expanded with increased levels of funding.

3c) Establish a joint industry, academic, and government group, to continuously monitor, identify, implement and fund effective continuing education programs focused specifically on developing expertise in key areas of technology, management and marketing. Suitable industry representatives should be encouraged to provide courses under the overall direction of the Academic Coordinator.

3d) Increase government support, through direct subsidy or tax incentives, for employer-based training in developing necessary technical, marketing and management expertise.

3e) Redirect government and industry funding to post- and pre-secondary institutions to encourage courses and research in specific areas of information technology which are a key to growth in the industry.

3f) In order to meet the industry's need for improved and expanded levels of management, marketing and specialized technical expertise, post secondary institutions should develop an agressive plan that can be supported by both government and industry.

RECOMMENDATION 4

Increase the resources provided to the Science Council of British Columbia for the specific purpose of implementing policies and developing programs directed toward stimulation of the Information Technology industry.

In recent years, the Science Council of British Columbia and its Information Technology sector, have tended to be reactive in supporting the growth of Science and Technology in British Columbia rather than proactive in providing leadership to governments and industry. Current budgets provided to the Science Council of British Columbia do not reflect the current or potential contribution of the high technology industry to the economy, more specifically in the area of Information Technology.

The Science Council and the various sub-committees (sectors) are composed of prominent and influential members of the industry, academic community and government. The collective talent, with the appropriate mandate, encouragement and resources, can become a powerful mechanism in both strategic planning and implementation of policies and programs promoting growth in the industry. It is our understanding that the government is re-writing the Science Council Act to provide the Science Council of British Columbia with a much stronger mandate and opportunities to play a more pro-active role in the growth of science and technology within the province.

ACTIONS

4a) Increase funding to the Science Council of British Columbia to allow significantly more investment in all programs relating to the stimulation of the Information Technology industry.

The Information Technology industry in British Columbia has developed a number of strengths in specific areas. Recognizing that rapid growth and achievement of world leadership in a few areas of information technology can only be achieved by focussing science resources in areas of strength, the Science Council of British Columbia should focus their resources in the following areas:

- Wireless and mobile communications technology
- Applications software development
- Information technology applications to British Columbia's primary resource industries.

In order to prepare for the future, investment must be made in a number of emerging technologies which will become critical to the development of products in key niche.

Although further investigation is required to develop a comprehensive list of critical emerging technologies, the following technologies should be considered for investment:

- expert systems applications
- software development methodology, tools, techniques and systems
- wireless and R.F. technology
- information and speech coding synthesis and recognition
- electro optics
- mechatronics

4b) When coupled with technical research and development, market research should be included as a legitimate activity in funding Information Technology projects under the Science Council of British Columbia's A.G.A.R. program.

4c) Provide resources to the Science Council of British Columbia's Information Technology sector to continuously monitor and identify opportunities and problems in focussing Science Council and government resources.

4d) Provide necessary resources and seed money to the Science Council of B.C. which would be used to attract federal government grants, R&D funding, and financial assistance for provincial industry and university communities.

4e) Ensure that the Science Council fully coordinates its activities with those of the Ministry of Economic Development to encourage full recognition of marketing in the implementation of these recommendations.

RECOMMENDATION 5

Develop government and industry infrastructure within the province to reduce risks and maximize growth opportunities for members of the Information Technology industry at all levels of the growth continuum.

Success in the Information Technology industry depends upon a company's speed and effectiveness in moving the business over a number of major hurdles that are encountered by every company. Success during the initial technical feasibility, proof phase is as critical as the later market and distribution channel development phases.

Although there is a strong undercurrent of entrepreneurism in British Columbia in Information Technology, most of the companies in the province are relatively small and have been formed within the last 5 - 10 years. On the average, Information Technology companies in Quebec and Ontario are 30% to 80% larger (in terms of number of employees), than companies in British Columbia. Companies in British Columbia, in general, face a major challenge and difficulty in growing beyond what is considered a medium sized company (less than 1000 employees). None of these medium sized companies would be considered medium or large on a world wide basis.

Start up companies face different kinds of challenges. Access to government labs in Ottawa for technology and/or research and development support, and access to government funding for market development, are virtually taken for granted by most start up companies in the Ottawa - Toronto - Montreal golden triangle. Such a well developed infrastructure is not readily accessible to a start up company in British Columbia. Searching through the maze of assistance, financial or otherwise that may be available both locally and elsewhere, is often a major headache for an entrepreneur.

We recommend development and consolidation of existing infrastructure within the province to assist start up companies in establishing a strong foothold and the support of small and medium size companies to achieve levels of growth that are competitive in the global Information Technology industry.

Exhibit 16, although not all inclusive, shows various phases, where Information Technology companies of various sizes may require assistance and support to sustain continued growth.

In addition to the activities shown in the Exhibit, the proposed Wireless Communication Centre and the Pacific Microelectronic Corporation, which are still under consideration, are expected to be significant additions to the local support structure for the information technology industry.

EXHIBIT 16

KEY SUPPORT REQUIREMENTS DURING DIFFERENT PHASES OF BUSINESS DEVELOPMENT IN A TYPICAL INFORMATION TECHNOLOGY COMPANY

	Start-Up 0-10 Employees	Small 10-100 Employees	Medium 100-1000 Employees
Research and development funding and incentives that include market research	X	X	X
Office space and shared infrastructure including equipment labs and business advice and expertise, recruitment of technical personnel	X		
Business plan development	X	X	X
Knowledge of raising risk capital	X	X	
Software development tools	X	X	
VLSI design tools and facility	X	X	X
Manufacturing and packaging infrastructure	X	X	X
Export Market Development	X	X	X
Development of Sales and Distribution channels	X	X	X
Market and Sales Training	X	X	X
Formation of Joint Ventures and Partnerships		X	X
Attraction of experienced management and assistance with strategic planning		X	X
Establishment of first customer for testing and demonstration of new products and services.	X	X	

ACTIONS

5a) **An individual with information technology and business development background should be appointed to:**

- **identify industry requirements for support,**
- **maintain an inventory of existing infrastructure,**
- **develop and maintain a data base containing information with respect to type of products produced, number of employees, annual sales volumes, research and development expenditures, etc., for all companies in the Information Technology industry in British Columbia,**
- **focus the activities and resources of the Discovery Foundation, Electronic Manufacturers Association, the Microelectronic Society and the Software Industry Development Association in identifying problems and opportunities, and developing strategic plans.**

Small start up companies in the information technology industry frequently have difficulty in raising the required capital. The Cal Tech Venture Forum in Los Angeles, California was formed to address the problems experienced by these companies. In the Cal Tech Venture Forum, company executives give a short presentation to an audience of institutional investors, bankers, corporate investors, and venture capitalists who would not only develop a good understanding of business opportunities, but also provide useful critique and advice to the companies. Such a forum may provide more exposure and opportunity to a small company in an afternoon than they would normally get in a year of constant meetings to find potential investors.

5b) **Establish a venture forum including major banks, venture groups, and the Vancouver Stock Exchange to allow Information Technology companies (requiring risk capital to get exposure on a regular basis).**

5c) **Establish a joint industry-government association to take a pro-active role in pulling various Information Technology companies together in developing joint bids for major national and international contracts and business opportunities.**

5d) **React quickly and positively toward local industry initiatives to establish appropriate Centres of Excellence such as the Wireless Communication Centre, Pacific Microelectronics Corporation and the MacDonald Dettwiler's Resource Information and Management System.**

5e) Add an Information Technology officer to the existing Economic Development Office in Ottawa, charged with the responsibility of drawing a larger share of Federal R & D and infrastructure grants, with assisting Information Technology companies in British Columbia in gaining access to opportunities in Eastern Canada and identifying joint venture opportunities for local B.C. companies.

5f) Develop a provincial government bid and performance bond program to assist smaller companies in bidding on contracts in export markets.

APPENDIX A

PROCESS USED TO ESTIMATE THE SIZE AND VALUE OF THE INFORMATION TECHNOLOGY INDUSTRY

Statistical information available from Statistics Canada, with respect to the number of companies, employment and sales revenues in the various sectors of the information technology industry is out of date (1985 is the latest) and inaccurate with respect to the number of companies included in the surveys. In order to obtain more current information specific to information technology industry in British Columbia, the membership lists of the following organizations were cross matched to eliminate duplications and those companies not directly involved in developing or producing products:

- Electronic Manufacturers Association of B.C.
- B.C. Microelectronic Society
- Software Industry Development Association of B.C.
- Ministry of Economic Development High Technology Listing

There are a few companies in the industry that do not appear in any of these listings. With respect to the software industry, there are many people employed in software development inside companies that are not directly related to the industry, while others are employed in large companies or organizations which are principally involved in sales or services rather than product development and manufacturing.

It was therefore concluded that the data base prepared from the available listings was a minimum number of the companies and employment related to the development and manufacturing of information technology products.

Employment in the industry was estimated as follows:

- where information was available regarding the number of employees in an organization, a range was assigned to the company as follows:

1 - 1 to 5	6 - 100 to 199
2 - 6 to 14	7 - 200 to 499
3 - 15 to 24	8 - 500 to 999
4 - 25 to 49	9 - 1000 +
5 - 50 to 99	

- where information was not available, employment code 1 was assigned

- in calculating the total number of employees in each sector of the industry, the mid-point in the range assigned to each company was used in the addition.

Gross sales revenues were estimated for the Communications, Electronics and Computers Sectors using $100,000 per employee as the standard. Data available from the Statistics Branch of the Ministry of Economic Development estimates sales per employee in this sector at $119,000 per employee. These figures were cross checked with the sales/employment data that was available from some of the major companies in the industry and were found to be accurate.

Gross sales revenues in the software industry were based on the estimates provided in the recent report to the Software Industry Development Association by the Corum Group from Seattle. The estimate of $72 million based on 330 companies, employing 1,500 people, indicates a sales/employee ratio of approximately $50,000 to 1.

SUMMARY OF RECOMMENDATIONS FROM ALL SECTORS

AGRICULTURE AND FOOD PROCESSING

RECOMMENDATIONS (CONT'D.)

- FUNDING FOR SECONDARY MANUFACTURE, FOOD PROCESSING
- RESEARCH ORGANIZATIONS STAFFING AND EQUIPMENT
- GENERAL AWARENESS
- TECHNOLOGY TRANSFER

Science Council of British Columbia

Helping Make Tomorrow Happen in B.C.

AQUATIC RESOURCES

$750M INDUSTRY

AQUACULTURE - HIGH GROWTH
- SCIENCE ISSUES

RECOMMENDATIONS

- WATER QUALITY
  - SPECIFIC CONTAMINANTS
  - AQUACULTURE
- AQUATIC INSTRUMENTS AND DEVICES
  - INTERFACE WITH SECTOR
  - GROWTH AREA
- FISH HARVESTING
  - GOVERNMENT AND SOCIAL POLICIES
  - IMPROVEMENTS POSSIBLE
  - SHIP/SHORE COMMUNICATION

AQUATIC RESOURCES

RECOMMENDATIONS (CONT'D.)

- FISH PROCESSING
  - NEW PRODUCTS
  - BY-PRODUCTS
  - QUALITY
  - PACKAGING
- AQUACULTURE
  - INTERFACE WITH BIOTECHNOLOGY
    - DISEASE CONTROL
    - NUTRITION
    - GENETICS
    - WASTE MANAGEMENT
  - NETWORK OF EXCELLENCE

BIOTECHNOLOGY

EMERGING INDUSTRY - $12M

IMPACTS ON MANY SECTORS - FORESTS
- AGRICULTURE
- AQUACULTURE
- HEALTH
- WASTE MANAGEMENT
- MINING

NEED FOR STRATEGIC PLANNING, CO-ORDINATION

RECOMMENDATIONS

- FOCUS ON
  - DISEASE CONTROL
  - GENETIC IMPROVEMENT
  - WASTE MANAGEMENT
- STRATEGIC PLANNING - USE OF EXISTING COMMITTEE
- LONG TERM COMMITMENT OF FUNDING
- RAISE FUNDING FROM $10M TO $30M - 5-10 YEARS

BIOTECHNOLOGY

RECOMMENDATIONS (CONT'D.)

- STRATEGIC RESEARCH, TRAINING, SCHOLARSHIPS
- INDUSTRY/UNIVERSITIES INTERACTION
- REVIEW FACILITIES NEEDS AND CO-ORDINATION

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ENERGY

MAJOR RESOURCE OF PROVINCE

DEPENDENCE OF OTHER RESOURCE SECTORS

OIL - IMPORT TO B.C.

NATURAL GAS SURPLUS

RECOMMENDATIONS

- OIL & GAS
  - DEVELOP UNDERSEA ROBOTICS
  - PREPARE FOR SWITCH AWAY FROM OIL
  - NATURAL GAS DIESEL ENGINE CONVERSION
- COAL
  - DEVELOP CAPABILITY TO ANALYZE COALS
  - BENEFICIATION & TRANSPORTATION
  - ALTERNATIVE USES

ENERGY

RECOMMENDATIONS (CONT'D.)

- WOOD RESIDUE AND BIOMASS

  - CONTINUE DEVELOPMENTS - METHANOL, ETHANOL

- OTHERS

  - HYDROGEN
  - FUEL CELL

SCIENCE & TECHNOLOGY ENERGY FOCUS

- CENTRE FOR ENERGY STUDIES
- BUILD EXPERTISE
- UNDERTAKE TESTS
- NATURAL GAS
- LONGER TERM ITEMS

FORESTS AND FOREST PRODUCTS

GROWTH AREA

MOVING TO VALUE ADDED PRODUCTS

RESOURCE DIMINISHING AND MORE EXPENSIVE

WORLD-WIDE COMPETITION

DEPENDENCE ON SCIENCE & TECHNOLOGY

ADVANCED MACHINERY AND SYSTEMS

PEOPLE NEEDS

RECOMMENDATIONS

- OVERALL CO-ORDINATION FOR SCIENCE AND TECHNOLOGY
- ADD VALUE
- IMPROVE PRODUCTION FOR RESOURCE

FORESTS AND FOREST PRODUCTS

RECOMMENDATIONS (CONT'D.)

- RAISE TECHNOLOGICAL AWARENESS AND COMPETENCE
  - RESEARCHERS
  - 'RECEPTORS'
- TECHNOLOGY TRANSFER
- USE OF ADVANCED SYSTEMS, TECHNOLOGIES AND MACHINERY

INFORMATION TECHNOLOGY

$1 BILLION INDUSTRY

11,500 PEOPLE

25%-50% ANNUAL GROWTH

RESOURCE INDUSTRIES/INFORMATION TECHNOLOGY

PEOPLE NEEDS

CO-ORDINATED ACTIONS

RECOMMENDATIONS

- ENHANCE RESOURCE INDUSTRIES BY ENHANCING THE INFORMATION TECHNOLOGY INDUSTRIES
- COMMIT TO INFORMATION TECHNOLOGY
- MARKETING, MANAGEMENT, TECHNICAL PEOPLE
- CO-ORDINATION AND PLANNING ROLE
- INFRASTRUCTURE AND SUPPORT

MANUFACTURING

IMPORTANCE TO PROVINCE

4,000 COMPANIES - 40 LARGE

LACK OF TRAINING

DIFFICULTIES OF LOCATING PARTNERS

TECHNOLOGY TRANSFER - SMALL COMPANIES

RECOMMENDATIONS

- STRATEGIC PLAN - 'CHAMPION'
- BIOMEDICAL DEVICES
- EDUCATION AND TRAINING
- TECHNOLOGY CENTRE
- RESOURCE INDUSTRIES - ROBOTICS
- NETWORKING
- CAD/CAM
- FUNDING

MINING, MINERALS, METALS

NEEDS

- INDUSTRY INVOLVEMENT
- NATIONAL CO-ORDINATION
- FOCUS ON R&D
- RAISING AWARENESS

RECOMMENDATIONS

- R&D CO-ORDINATOR FOCUSSED ON B.C. NEEDS, NATIONAL INTERFACE

- INDUSTRY CHAIRS - ADVANCED MATERIALS

- CENTRES OF EXCELLENCE:

  - ADVANCED MATERIALS
  - INDUSTRIAL MINERALS
  - GEOLOGICAL EXPLORATION
  - RARE & PRECIOUS METALS

EMERGING THEMES

- BUILD ON EXISTING COMPANIES, ORGANIZATIONS AND INDIVIDUALS
- ORGANIZED STIMULATION OF INTERACTION AND PLANNING WITHIN AND BETWEEN SECTORS
- RESOURCE INDUSTRY FOCUSSED, TECHNOLOGY DRIVEN CENTRES OF EXCELLENCE
- VALUE ADDED PRODUCTS FROM RESOURCES USING TECHNOLOGY DEVELOPED IN B.C.
- DEVELOP THE MARKETING, MANAGEMENT AND TECHNICAL TALENTS OF OUR PEOPLE
- EFFECTIVE USE OF SIGNIFICANTLY MORE R&D SPENDING

AGRICULTURE AND FOOD PROCESSING

PRIMARY AGRICULTURE

- ROLE OF AGRICULTURE CANADA
- VERY SMALL AVAILABLE LAND BASE

SECONDARY MANUFACTURE

- POTENTIAL GROWTH AREA

FOOD PROCESSING

- POTENTIAL GROWTH AREA

RECOMMENDATIONS

- INTERFACE WITH BIOTECHNOLOGY
  - DISEASE CONTROL
  - GENETICS
  - WASTE MANAGEMENT
- VALUE ADDED
  - FOOD PROCESSING
- INCREASE PRODUCTIVITY
- INCREASE INDUSTRY INVOLVEMENT
  - CO-OPERATIVE RESEARCH